International Journal of Agricultural Science and Research (IJASR)
ISSN (P): 2250-0057; ISSN (E): 2321-0087
Vol. 9, Issue 4, Aug 2019, 61-68

THE TECHNICAL EFFICIENCY AND RESOURCE USE EFFICIENCY OF BLACK GRAM PRODUCTION IN VILLUPURAM DISTRICT OF TAMIL NADU

G. SHYAMSUNDAR[1], DR. R. RAJESH[2] & J. J. PARTHIBAN[1]

[1]PG Scholars, Agricultural Economics & Head, Department of Differently Abled Studies, CSC & RI, Tamil Nadu Agricultural University, Madurai, Tami Nadu, India

[2]Professor, Agricultural Economics & Head, Dept. of Differently Abled Studies, CSC & RI, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India

ABSTRACT

The present study was an attempt to estimate resource use efficiency and technical efficiency of Black gram producing farms in Villupuram district of Tamil Nadu. Multi stage random sampling was used to collect the data from the farmers. Data Envelopment Analyses (DEA) and regression models were used for estimating the technical and resource use efficiency and its determining factors respectively. Coefficient of multiple determinations (R^2) in the fitted Cobb Douglas production was 0.89. The R^2 value for small, medium and large farms were 0.87 and 0.87 respectively. Most of the farms had the potential to expand production and productivity. Out of 120 farms, nearly 70 farms were found to be increasing returns to scale, increasing technical efficiency as majority have been performing with increasing return to scale.

KEYWORDS: Data Envelopment Analyses (DEA) & Black Gram

Original Article

Received: May 07, 2019; **Accepted**: May 28, 2019; **Published**: Jun 13, 2019; **Paper Id**.: IJASRAUG201910

INTRODUCTION

Pulses were important source of stable protein food for the poor which constitute a major population in the country. The recommended dietary allowances (RDA) for adult male and female was 60 gram and 55 gram per day respectively. The per capita availability of pulses was at 42 gram per day [(1).] Black gram (Vigna mungo) originated from central Asia and India from where it was domesticated. It was now found in many tropical where as in Asia, Africa and Madagascar. It was cultivated in USA and Australia as a fodder crop (Jansen, 2006; et al., 1989). India was the largest producer as well as consumer of Black gram in the world. In India, Madhya Pradesh stands first in respect of whereas 24.11 per cent followed by Uttar Pradesh 16.71 per cent and Andhra Pradesh 11.05 per cent, whereas in production Madhya Pradesh stands first 22.32 per cent followed by Andhra Pradesh 15.65 per cent and Uttar Pradesh 14.49 per cent. The highest yield was recorded by the state of Bihar (898 kg/ ha) followed by Jharkhand (875 kg/ha) and Andhra Pradesh (846 kg / ha). The national yield average was (597 kg/ha). The lowest yield was recorded in the state of Chandigarh (310 kg/ha) followed by Odisha (325 kg/ha) and Karnataka (416 kg/ha) [(2)].

OBJECTIVES

- To estimate the resource use efficiency in Black gram production
- To estimate the technical efficiency using DEA

METHODOLOGY

The present study was conducted in Villupuram district of Tamil Nadu based on the major Black gram producing area. Further, primary data were collected from the Black gram farmers. The Multi stage random sampling procedure was used to choose the sample farmers. In First stage Villupuram district was elected based on the highest Black gram area. In second stage Four blocks having highest area under Black gram was selected. Later Three revenue villages from each block were chosen randomly in the third stage. Finally sample of thirty farmers from each block were selected and total sample 120 farmers were selected for the study. For this study a well-structured schedule was used.

Resource use Efficiency

To study the effect of various independent variables on the dependent variables, Cobb-Douglas production function was found the best fit for analyses of data.

The mathematical form of Cobb-Douglas function was as follows

The form of regression model used for the three categories, viz. small, medium and large farms was as follows

$Y = a\, X_1^{b1}\, X_2^{b2}\, X_3^{b3}\, X_4^{b4}\, X_5^{b5}\, U_t$

Where,

Y = Yield of rice (kgs /ha)

X_1 = quantity of farmyard manure (tones/ha)

X_2 = cost of fertilizer (Rs /ha.)

X_3 = human labour (mandays /ha.)

X_4 = machine hours (hrs /ha.)

X_5 = cost of plant protection (lit /ha.)

U_t = Error term

$a, b_1, b_2, \ldots b_5$ = Parameters to be estimated.

Data Envelopment Analyses

The DEA was applied by using both classic models CRS (constant returns to scale) and VRS (variable returns to scale) with input orientation, in which one showed input minimization to obtain a particular product level. Under the assumption of constant returns to scale, the linear programming model for measuring the efficiency of Black gram farms was selected based on the previous study (Coelli *et al.*, 1998):

Min θ, λ θ

Subject to - $y_i + Y\lambda \geq 0$ $\theta x_i - X\lambda \geq 0$ $\lambda \geq 0$ (1)

where, y_i was a vector ($m \times 1$) of Black gram output of the i^{th} Black gram Producing Farms (TPF), x_i was a vector ($k \times 1$) of inputs of the i^{th} TPF, Y was a Black gram output matrix ($n \times m$) for n TPFs, X was the Black gram input matrix ($n \times k$) for n TPFs, θ was the efficiency score, a scalar whose value will be the efficiency measure for the i^{th} TPF. If θ =1, TPF will be efficient; otherwise, it will be inefficient, and λ was a vector ($n \times 1$) whose values were calculated to obtain the optimum solution. For an inefficient TPF, the λ values will be the weights used in the linear combination of other, efficient, TPFs, which influence the projection of the inefficient TPF on the calculated frontier.

The specification of constant returns was only suitable when the firms work at the optimum scale. Otherwise, the measures of technical efficiency can be mistaken for scale efficiency, which considers all the types of returns to production, i.e., increasing, constant and decreasing. Therefore, the CRS model was reformulated by imposing a convexity constraint. The measure of technical efficiency obtained in the model with variable returns was also named as 'pure technical efficiency', as it was free of scale effects. The following linear programming model estimated it:

Min θ, λ θ

Subject to- $y_i + Y\lambda \geq 0$

$\theta x_i - X\lambda \geq 0$

$N_1 \lambda = 1$

$\lambda \geq 0$ (2)

where, N_1 was a vector ($n \times 1$) of ones.

When there were differences between the values of efficiency scores in the models CRS and VRS, scale inefficiency was confirmed, indicating that the return to scale was variable, i.e. it can be increasing or decreasing (Färe and Grosskopf, 1994). The scale efficiency values for each analyzed unit can be obtained by the ratio between the scores for technical efficiency with constant and variable returns as follows:

$\theta s = \theta CRS\ (XK, YK)/\theta VRS\ (XK, YK)$ (3)

where,

$\theta_{CRS}\,(X_{K,}Y_K)$ = Technical efficiency for the model with constant returns,

$\theta_{VRS}\,(X_{K,}Y_K)$ = Technical efficiency for the model with variable returns, and θ_s = Scale efficiency.

It was pointed out that model (2) makes no distinction as to whether TPF was operating in the range of increasing or decreasing returns (Coelli *et al.*, 1998). The only information one has was that if the value obtained by calculating the scale efficiency in Equation (3) was equal to one, the TPF will be operating with constant returns to scale. However, when θ_s was smaller than one, increasing or decreasing returns can occur. Therefore, to understand the nature of scale inefficiency, it was necessary to consider another problem of linear programming, i.e. the convexity constraint of model (2), $N_1\lambda = 1$, was replaced by $N_1\lambda \leq 1$ for the case of non-increasing returns, or by $N_1\lambda \geq 1$, for the model with non-decreasing returns. Therefore, in this work, the following models were also used for measuring the nature of

efficiency.

Non-increasing returns:

Min θ, λ θ

Subject to $- y_i + Y\lambda \geq 0$ $\theta x_i - X\lambda \geq 0$

$N_1 \lambda \leq 1$

$\lambda \geq 0$ (4)

Non-decreasing returns:

Min θ, λ θ

Subject to- $y_i + Y\lambda \geq 0$ $\theta x_i - X\lambda \geq 0$

$N_1 \lambda \geq 1$

$\lambda \geq 0$ (5)

It was to be stated here that all the above models should be solved *n* times, i.e. the model was solved for each TPF in the sample.

Black gram production (t/ha) was used as an output (Y) in the present case and total male labour (man days), total female labour (women days), seeds/plant population (No.), farm yard manure (t), plant nutrients N (kg), P (kg), K (kg) separately, capital inputs (Rs) on plant protection, other input costs and fixed input costs as inputs (X). The models were solved using the DEAP version 2.1 taking an input orientation to obtain the efficiency levels **(Srinivasa Murthy et al., 2009).**

RESULTS AND DISCUSSIONS

Resource use Efficiency

Table 1: Estimation of Resource use Efficiency in All Farms

S. No	Variables	Regression Coefficient	Standard Error	Significance
1.	Regression Constant	3.35	0.35	**
2.	FYM (t/ha)	0.15	0.05	**
3.	Chemical fertilizer (Rs. /ha)	0.09	0.07	NS
4.	Human labour (man days/ha)	0.35	0.11	**
5.	Machine hours (hrs/ha)	0.46	0.06	NS
6.	Plant protection chemicals (lit/ha)	0.04	0.04	*

R^2 = 0.89 N=120 F-ratio=64.64

Note:

** Significant at 1 percent level

* Significant at 5 percent level

NS Non-significant

The coefficient of farmyard manure and human labour were positive and significant at one percent level with coefficient values of 0.15 and 0.35 respectively, which indicated that increase in usage of farmyard manure and human labour by one percent from the existing mean level, ceteris paribus could increase the yield of Black Gram by 0.15 and 0.35 percent respectively.

The coefficient of plant protection chemical was positive and significant at one percent level with coefficient value 0.04 indicating that one percent increase in plant protection chemical ceteris paribus would increase 0.04 percent yield in Black Gram. The variable chemical fertilizer and machine hours found to be non-significant.

Resource use Efficiency of Black Gram in Small Farms

Table 2: Estimation of Resource use Efficiency of Black Gram in Small Farms

S. No	Variables	Regression Coefficient	Standard Error	Significance
1.	Regression Constant	2.17	0.51	**
2.	FYM (t/ha)	-0.06	0.06	NS
3.	Chemical fertilizer (Rs. /ha)	0.18	0.09	*
4.	Human labour (man days/ha)	0.56	0.14	**
5.	Machine hours (hrs/ha)	0.45	0.07	NS
6.	Plant protection chemicals (lit/ha)	0.06	0.05	*

R^2=0.87 F-ratio=23.93 N=90

Note:

** Significant at 1 percent level
* Significant at 5 percent level
NS Non-significant

The coefficient of chemical fertilizer and plant protection chemicals were positive and significant at five percent level with coefficient values 0.18 and 0.06 respectively, which indicates that increase in usage of chemical fertilizers and plant protection chemicals by one per cent, Ceteris paribus would increase the yield of Black Gram by 0.18 and 0.06 percent respectively.

The coefficient of human labour was significant at one percent level with coefficient value of 0.56 indicating that one percent increase in human labour, Ceteris paribus would increase the yield of Black Gram by 0.56 respectively. The variable farmyard manure and machine hours found to be non-significant.

Resource use Efficiency of Black Gram in Medium and Large Farms

The coefficient of plant protection chemicals and human labour were positive and significant at one percent level with coefficient value 0.21 and 0.06 respectively, which indicates that an increase in usage of plant protection chemical and human labour by one percent, ceteris paribus would increase the yield of Black Gram by 0.21 and 0.06 percent respectively.

Table 3: Estimation of Resource use Efficiency in Medium and Large Farms

S. No	Variables	Regression Coefficient	Standard Error	Significance
1.	Regression Constant	4.06	0.79	**
2.	FYM (t/ha)	-0.01	0.13	NS
3.	Chemical fertilizer (Rs. /ha)	0.06	0.14	NS
4.	Human labour (man days/ha)	0.21	0.22	*
5.	Machine hours (hrs/ha)	0.63	0.16	**
6.	Plant protection chemicals (lit/ha)	0.06	0.07	*

R^2=0.87 F-Ratio=33.22 N=30

Note:

** Significant at 1 percent level
* Significant at 5 percent level
NS Non-significant

The coefficient of machine hours was positive and significant at five percent level with coefficient value 0.63 which indicates that an increase in usage of machine hours by one percent, ceteris paribus would increase the yield of

Black Gram of 0.63 percent respectively. The variable farmyard manure and chemical fertilizers was found to be non-significant.

Estimation of Technical Efficiency using DEA

Table 4: Efficiency Measures and Descriptive Statistics or Black Gram producing Farms According to Scale of Operations in the Study Area

Scale of Operation	Efficient Firms (0>0.90)		Efficiency Measures			
	No.	%	Mean	Standard Deviation	Maximum	Minimum
Small Farms						
Technical efficiency (constant returns)	60	66.67	0.84	0.11	1	0.63
Technical efficiency (variable returns)	39	43.33	0.91	0.09	1	0.68
Scale efficiency	28	31.11	0.92	0.08	1	0.69
Medium and Large Farms						
Technical efficiency (constant returns)	7	23.33	0.93	0.12	1	0.46
Technical efficiency (variable returns)	4	13.33	0.95	0.11	1	0.51
Scale efficiency	2	15.00	0.97	0.05	1	0.76
All Farms						
Technical efficiency (constant returns)	91	75.83	0.68	0.23	1	0.25
Technical efficiency (variable returns)	58	48.33	0.86	0.16	1	0.34
Scale efficiency	79	65.83	0.79	0.22	1	0.27

Estimation of Technical Efficiency in Small Farms

With the assumption of constant scale and the model with variable returns to scale was calculated, the impact of production scale on technical efficiency level was visible. In small farms the average efficiency score increased to 0.92. Further, the lower value of standard deviation of mean in model with variable returns suggested concentration of farms in higher efficiency levels.

As regards to scale efficiency 31.11 percent of Black Gram farms under small farm category either performed at optimum scale or were close to optimum scale.

Estimation of Technical Efficiency in Medium and Large Farms

Under the assumption of constant returns to scale, 23.33 percent of the farmers in medium and large category were found efficient with values equal to or more than 0.90. The average technical efficiency score was higher in this category at 0.93.

In variable returns, the average technical efficiency score 0.95 and nearly 13.33 percent of the farms had the equal sore to or more than 0.90. As regards to scale efficiency 15 percent of Black Gram farms under medium and large farm category at optimum scale or were close to optimum scale.

Regions of Operation in Production Frontier

Table 5: Distribution of Black Gram Farms in the Study Area According to Types of Returns Among Different Scale of Operations

Types of Returns	Small Farms		Medium and Large Farms		All Farms	
	No	%	No	%	No	%
Increasing returns	54	60.00	4	13.33	70	58.33
Constant returns	17	18.89	21	70.00	17	14.17
Decreasing returns	19	21.11	5	16.67	33	27.50

Note: % indicates percent to individual category of farms

In medium and large farm category 13.33 percent of the farms were found operating in the region of increasing returns or sub optimal regions. The production scale of these farms could be increased by decreasing costs. It was observed that 70.00 percent of the Black Gram farms in the medium and large category who were found in decreasing returns or supra optimal regions. Nearly 16.67 per cent Black gram farms were found in constant returns were found operating.

In the all farm category 58.33 percent of the farms were found operating in the region of increasing returns or sub optimal regions. The production scale of these farms could be increased by decreasing costs. Nearly 14.17 per cent of the Black Gram farms in all farms category who were found in decreasing returns or supra optimal regions. In the constant region only 16.67 per cent of the farms were found operating.

SUMMARY AND CONCLUSIONS

It was inferred from the study that the selected functional analysis was good fit. It was further observed that mostly human labour, Farm yard manures, chemical fertilizers and plant protection chemicals were positive and significant. In medium and large farms Machine labour was positive and significant at one per cent level which contributes to increase in the yield of Black gram. In technical efficiency the average efficiency scores of small farms were 0.84. In medium and large farms, the average technical efficiency scores were 0.93. In variable returns the average technical efficiency scores of small farms and medium and large farms were 0.92 and 0.95 respectively. Most of the farms were found operating in region of increasing returns or sub optimal regions

REFERENCES

1. *Battese, G. and Coelli, T. (1988) Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data, Journal of Econometrics, **28**: 387-399.*
2. *Battese, G. (1992) Frontier production functions and technical efficiency: A survey of empirical applications in agricultural economics. Agricultural Economics, **7**: 185208.*
3. *Battese, G. and Coelli, T. (1992) Frontier production functions, technical efficiency and panel data: With application to paddy farmers in India, Journal of Productivity Analyses, **3**: 153-169.*
4. *Socio-Economic Valuation of Information for Climate Change Adaptation and Mitigation: A Case of Farmersâ€™ Responses in Kakamega County*
5. *Ganeshkumar DR, Kakde SJ, and Khobarkar, V (2013) Resource Use Efficiency in Gram Production of Amravati Divwasion Volume: 3, Wassue: 9, Sept 2013, WASSN - 2249-555X.*

6. *Singh Jitendra; Singh, AK and Kwashor, Raj (2007). Resource-use efficiency of sugarcane cultivation in Western Region of Uttar Pradesh. Indian-Sugar. 57(9): 73-83.*
7. *[(1)], [(2)] (Annual Report DPD 2016-17).*